

We claim:

1 1. A method for communicating between a first Fibre Channel (FC) enabled device and a  
2 second FC enabled device, where the communication occurs across a fabric that operates in  
3 accordance with a first protocol different from a FC protocol of the first and second FC enabled  
4 devices, the method comprising:

5 receiving, from the first FC enabled device, at a first gateway receiver a sequence of  
6 bytes including at least one control character in accordance with the FC protocol;

7 replacing the at least one control character with at least one data character;

8 generating an encapsulation header and an encapsulation footer;

9 setting a control character indicator in the encapsulation header if a first byte in the  
10 sequence of bytes received at the gateway receiver is a control character; and

11 setting an end of frame indicator in the encapsulation footer if a last byte in the sequence  
12 of bytes received at the first gateway receiver is an end of frame control character.

1 2. The method of claim 1, further comprising encapsulating the sequence of bytes with the  
2 encapsulation header and encapsulation footer.

1 3. The method of claim 1, wherein the first protocol is gigabit ethernet.

1 4. The method of claim 1, wherein the at least one control character is a K28.5 character.

1 5. The method of claim 1, wherein the at least one data character is a D28.5 character.

1 6. The method of claim 2, further comprising:

2 placing at a controller the encapsulated sequence of bytes in a packet composed in  
3 accordance with the first protocol to produce a packetized encapsulated sequence; and

4 transmitting, through the fabric, from the controller to a second gateway receiver the  
5 packetized encapsulated sequence.

1 7. The method of claim 6, wherein the transmitting by the controller is performed at a  
2 transmission rate, and the receiving at the first gateway receiver is performed at a reception rate  
3 that is less than the transmission rate.

1 8. The method of claim 6, further comprising:  
2 receiving at the second gateway receiver the packetized encapsulated sequence;  
3 removing the encapsulation header and the encapsulation footer; and  
4 replacing the at least one data character with the at least one control character to produce  
5 a regenerated sequence of bytes.

1 9. The method of claim 8, wherein replacing the at least one data character results in an end  
2 of file control character being placed in the regenerated sequence of bytes.

1 10. The method of claim 8, further comprising transmitting the regenerated sequence of bytes  
2 to the second FC enabled device.

1 11. A gateway for communicating among a first device and a second device, both of which  
2 operate in accordance with a fibre channel (FC) protocol, and an intermediate network coupling  
3 the first device to the second device and having a first protocol, the gateway comprising:  
4 a first gateway receiver that is to receive a sequence of bytes including at least one  
5 control character in accordance with the FC protocol;  
6 a first gateway transmitter that is to replace the at least one control character with at least  
7 one data character and to generate an encapsulation header and an encapsulation footer; and  
8 wherein the transmitter is to set a control character indicator in the encapsulation header  
9 if a first byte in the sequence of bytes received at the gateway receiver is a control character, and  
10 to set an end of frame indicator in the encapsulation footer if another byte in the sequence of  
11 bytes received at the first gateway receiver is an end of frame control character.

1 12. The gateway of claim 11, wherein the transmitter encapsulates with the encapsulation  
2 header and the encapsulation footer the sequence of bytes in which at least one control character  
3 was replaced with at least one data character.

1 13. The gateway of claim 11, further comprising a controller that is to place the encapsulated  
2 sequence of bytes in a packet composed in accordance with the first protocol to produce a  
3 packetized encapsulated sequence and that is to transmit, through the intermediate network, from  
4 the controller to the second device the packetized encapsulated sequence.

1 14. The gateway of claim 11, wherein the first protocol is gigabit ethernet.

1 15. The gateway of claim 11, wherein the at least one control character is a K28.5 character.

1 16. The gateway of claim 11, wherein the at least one data character is a D28.5 character.

1 17. The gateway of claim 12, further comprising a controller that is to place the encapsulated  
2 sequence of bytes in a packet composed in accordance with the first protocol to produce a  
3 packetized encapsulated sequence and that is to transmit, through the intermediate network, from  
4 the controller to a second gateway receiver the packetized encapsulated sequence.

1 18. The gateway of claim 17, wherein the controller is to transmit at a transmission rate, and  
2 the receiving at the first gateway receiver is performed at a reception rate that is less than the  
3 transmission rate.

1 19. A gateway for communicating among a first device and a second device, both of which  
2 operate in accordance with a fibre channel (FC) protocol, and an intermediate network coupling  
3 the first device to the second device and having a first protocol, the gateway comprising:

4 a first gateway receiver that is to receive a packetized encapsulated sequence in  
5 accordance with the first protocol from the intermediate network and to determine whether the  
6 packetized encapsulated sequence contains bytes to be forwarded to the first device;

7 wherein the first gateway receiver is to depacketize the packetized encapsulated sequence  
8 to produce an encapsulated sequence and to forward the encapsulated sequence to the first device  
9 if the packetized encapsulated sequence contains bytes to be forwarded to the first device; and

10 a first gateway transmitter that is to receive the encapsulated sequence, to remove an  
11 encapsulation header and an encapsulation footer from the encapsulated sequence to produce a

12 decapsulated sequence, and to replace in the decapsulated sequence at least one data character  
13 with at least one control character if an indicator in at least one of the header or footer indicates  
14 replacement.

1 20. The gateway of claim 19, further comprising an encoder that is to transmit to the first  
2 device in accordance with the FC protocol the decapsulated sequence.

1 21. The gateway of claim 20, wherein the controller is to receive at a receive rate, and the  
2 encoder transmits at a transmission rate less than the receive rate.

1 22. The gateway of claim 19, wherein the first protocol is gigabit ethernet.

1 23. The gateway of claim 19, wherein the at least one control character is a K28.5 character.

1 24. The gateway of claim 19, wherein the at least one data character is a D28.5 character.

1 25. A method for conserving bandwidth in a fibre channel-to-non-fibre-channel-to-fibre  
2 channel network, the method comprising:  
3 determining presence of a change in an initial sequence of words;  
4 repeatedly adjusting an inactivity indicator to reflect lack of change in a subsequent  
5 sequence of words;  
6 reaching a threshold at the inactivity indicator when N identical words in the subsequent  
7 sequence of words are received; and  
8 transmitting the N identical words and ignoring other identical bytes in the subsequent  
9 sequence of words.

1 26. The method of claim 25, further comprising resetting the inactivity indicator to reflect  
2 beginning of the subsequent sequence of words upon determining the presence of a change in the  
3 initial sequence of words.

1 27. The method of claim 25, wherein transmitting the N identical words includes  
2 encapsulating the N identical words.

1 28. The method of claim 27, wherein encapsulating includes replacing control characters in  
2 the N identical words with data characters.

1 29. The method of claim 25, wherein the initial sequence of words is received at a gateway  
2 from a fibre channel device and the N identical words are transmitted from the gateway to  
3 another gateway.

1 30. An apparatus that conserves bandwidth in the retransmission on a high speed line  
2 information that is received on a low speed line, the apparatus comprising:  
3 word change detector that detects presence of a change in an initial sequence of words;  
4 an inactivity indicator coupled to the word change detector and that is repeatedly adjusted  
5 to reflect lack of change in a subsequent sequence of words;  
6 wherein the inactivity indicator is to reach a threshold when N identical words in the  
7 subsequent sequence words are received;  
8 a transmitter coupled to the inactivity indicator that is to transmit the N identical words  
9 and is to ignore other identical bytes in the subsequent sequence of words; and  
10 wherein the inactivity indicator is to be adjusted to reflect beginning of the subsequent  
11 sequence if the word change detector detects a change in the initial sequence of words.

1 31. The apparatus of claim 30, wherein the inactivity indicator is a counter that is to be reset  
2 upon detecting presence of a change in the initial sequence of words.

1 32. The apparatus of claim 30, wherein the transmitter is to encapsulate the N identical  
2 words.

1 33. The apparatus of claim 32, wherein the transmitter is to replace control characters in the  
2 N identical words with data characters.

1 34. The apparatus of claim 30, further comprising:  
2 a receiver at that is to receive the initial sequence of words from a fibre channel device;  
3 and  
4 wherein the apparatus is a gateway that couples a fibre channel network to a non-fibre  
5 channel network; and  
6 wherein the transmitter is to transmit the N identical words from the gateway to another  
7 gateway via a non-fibre channel fabric.